Planning the Motion of a Robotic Assistant for Space Applications

Completed Technology Project (2013 - 2017)

Project Introduction

Revolutions in computing hardware and software have brought about an age where robots and people will be able to peacefully and safely co-exist in the same environment. Robotic assistants have become increasingly relevant for tasks that are mundane or dangerous, and a driving force for the development of this technology are applications intended for space missions like those specified in NASA strategic roadmap STR04. Unfortunately, there is a vast deficit in automation when it comes to robots and people working the same environment, either separately or cooperatively. Today robots are either used in isolation, or are completely controlled by a skilled human operator. This work will develop the foundations for an automated robotic assistant, furthering the state-of-the-art in autonomous robotic motion planning and planning under uncertainty, i.e., noisy sensors or imperfect actuation. In this proposal, it is argued that planning must consider not only the short-term goal of moving to a particular point in space, but leave the system in a state where a higher-level task can be accomplished. It is also argued that uncertainty must be considered at the very early stages of planning. Current state-of-the-art planners are only able to handle planning under uncertainty for simplified systems. However, advances in planning algorithms have recently shown that realistic modeling of many kinds of uncertainty, known as planning in the belief space, can be performed in real-time for even complex robots. By incorporating planning considerations for both short and long-term goals alongside realistic modeling and planning for uncertainty, one major step toward the goal of an autonomous robotic assistant can be realized. Several techniques will be investigated ranging from reasoning over only a critical subset of the belief space while accounting for uncertainty, to modern Bayesian methods, which attempt to reason over the entire belief space and construct an optimal policy; the policy instructs the robot at every point in its environment. An automated robotic assistant would directly benefit NASA's goals in robotics, particularly in the sub-fields of autonomy, planning, and uncertainty. The proposed work is envisioned primarily for systems such as Robonaut 2. However, the work will be conducted in a principled and general way that will allow its application to other systems as well. Moreover, robotic autonomy has broad implications not only for NASA's interests, but also the potential for societal impacts as well. For example, an autonomous system which performs routine maintenance aboard the International Space Station could translate into a household robot which is able to assist in caring for elderly or disabled persons.

Anticipated Benefits

An automated robotic assistant would directly benefit NASA's goals in robotics, particularly in the sub-fields of autonomy, planning, and uncertainty. The work is envisioned primarily for systems such as Robonaut 2. However, the work will be conducted in a principled and general way that will allow its application to other systems as well. Moreover, robotic autonomy has broad implications

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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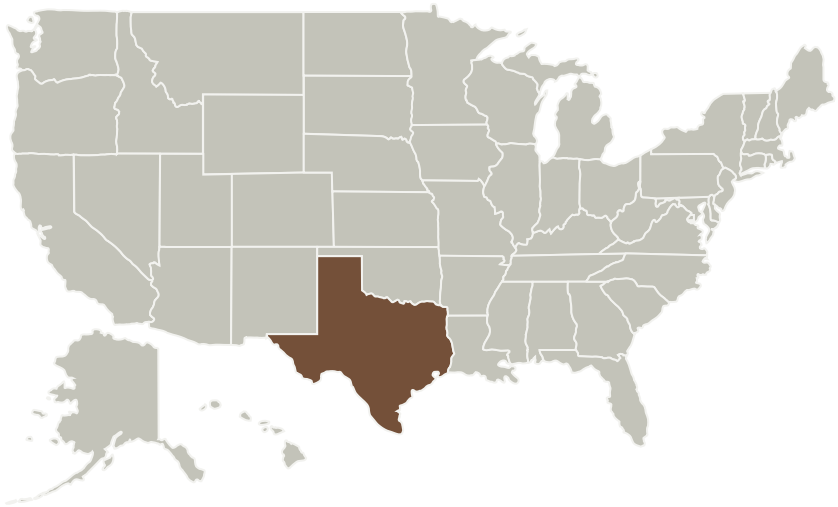
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Rice University	Supporting Organization	Academia	Houston, Texas

Primary U.S. Work Locations
Texas

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Project Management

Program Director:
Claudia M Meyer

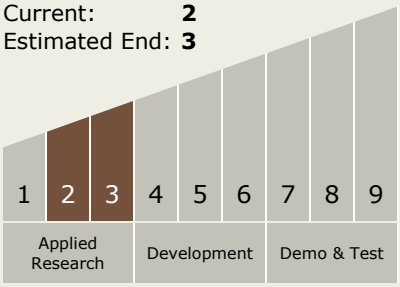
Program Manager:
Hung D Nguyen

Principal Investigator:
Lydia Kavraki

Co-Investigator:
Ryan J Luna

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.2 Reasoning and Acting
    - TX10.2.3 Motion Planning